WHAT IS CLAIMED IS:

1. A method for managing operational risk and return of a production infrastructure with respect to a current portfolio of service-level agreements, the method comprising:

a. calculating an efficient frontier that identifies efficient portfolios of SLAs using inputs such as characteristics of the production infrastructure, traffic and QoS characteristics and the price of each class of SLAs;

b. optionally, calculating a baseline efficient frontier using inputs such as market pricing and break-even pricing;

c. determining the performance of the current portfolio of SLAs using a portfolio evaluator means and inputs which characterize the current portfolio; and

d. evaluating performance by comparing the current portfolio and the efficient portfolios with the desired level of risk and return; and, if desired, implementing corrective action based on any desired risk and return.

2. The method of claim 1, wherein the corrective action is selected from a group of possible actions consisting of:

a. adjusting marketing strategy;

b. changing the degree of multiplexing in the network;

c. changing network capacity;

d. changing the cost of network capacity;

e. defining relative compliance guarantees where networks support definition of adequate policies on the basis of priority;

f. changing prices and comparing with baseline prices of SLAs; and

g. trading contracts of different classes of SLAs.

3. The method of claim 1 or claim 2 wherein, after corrective action is taken, the method takes new inputs, and, with the exception of the corrective action of trading SLAs, the method is re-executed, by calculating a new efficient frontier which is compared with performance of the current portfolio, calculated by the portfolio evaluator means.

4. The method of claim 2 wherein, for trading risk, the operator determines the number of to-be-traded SLAs of a certain class by subtracting the number of SLAs of the certain class in the current portfolio from the number of SLAs in a desired portfolio, and taking action that tends to narrow the difference; thus moving the contents of the current portfolio to that of an optimal portfolio.

5. A method for managing operational risk and return with respect to a portfolio of service-level agreements, wherein the method uses a

noncompliance risk measure to calculate risk; and wherein, principals of portfolio theory are applied to characterize the portfolio for comparison with other possible portfolios.

6. The method of claim 5, wherein the risk measure is selected from a group of quasi-linear noncompliance risk measures, the group consisting of a probability of noncompliance with loss guarantees, a probability of noncompliance with delay guarantees, an expected penalty for loss, and an expected penalty for delay.

7. The method of claim 5 wherein the risk measure is quasi-linear and the principals of portfolio theory are applied to calculate an efficient frontier, thus enabling a provider to select an efficient portfolio that maximizes return for a given risk or minimizes risk for a given return.

8. The method of claim 5, wherein the risk function is given by a probability of noncompliance with loss guarantees, *PNL*, which, once the distribution of $\boldsymbol{Y}$, a common random variable, which represents service times for customers of all classes, is known such as through historical data, the method computes from the formula: $PNL(c, L) = P[(Y-c)^{+} - LY > 0]$, where c is $C/\underline{y}$, $\underline{y}$ is the summation of a total amount of accepted bandwidths of Quality of Service class L_i, C is overall capacity of the network, $\underline{L}$ is a vector which characterizes the quality of each SLA, and $P[\underline{x}]$ denotes the probability of $\underline{x}$.

9. The method of claim 5, wherein the risk function is given by an expected penalty for loss, *EPL*, which the method computes over a time interval from the formula: $EPL(c, L) = (\beta C)\{E[(Y-c)+]-LE[Y]\}$, where c is $C/\underline{y}$, $\underline{y}$ is the summation of the total amount of accepted bandwidths of Quality of Service class L_i, C is overall capacity of the network, L is a vector which characterizes the quality of each SLA, β is a constant >0, so that (βC) denotes the penalty per capacity unit, E is statistical expectation, and L_i is a total of Quality of Service offered by class i.

10. The method of claim 5, wherein the risk function is given by an expected penalty for delay, *EPD*, which the method computes over a time interval from the formula: $EPD\,(c, L) = \beta\{\,(\alpha/(c-1)) - (D/c)\}$, where β is a constant > 0, $c = 1/\Sigma(\lambda_i/\mu_i)$, $D = c\ \Sigma\{(\lambda_i/\mu_i)\,D_i\}$, and $E[W_i]$ denotes the expected waiting time (i.e., delay) for class i, wherein further, assumptions are made that class i traffic arrives at Poisson rate λ_i, and that arrival processes are independent of each other; service times, characterized by service rate μ_i of class i, are independently distributed and independent of each other and of the arrival processes; that $\alpha=(1+\{Var[Y]/\mu^2\}^2)/2$ given that service times for customers of all classes are distributed as a random variable $\boldsymbol{Y}$ of mean μ, where $Var[\boldsymbol{Y}]$ denotes the variance of random variable $\boldsymbol{Y}$, and wherein noncompliance is a penalty for exceeding D_i and a

premium for remaining under D_i.

11. The method of claim 5, wherein the risk function is given by an expected penalty for delay, *EPD*, which the method computes, assuming Poisson traffic, from the formula: $EPD(\mathbf{v}) = \beta\sum v_i(E[W_i] - D_i)$, where $\mathbf{v}$ is a vector of traffic intensities, v_i is the traffic intensity of customers in class i, E is statistical expectation, β is a constant >0 so that βC denotes the penalty per capacity unit, W_i is waiting time for a class i, and D_i is the maximum permissible delay for a class i of SLAs.

12. A method for determining risk and return of a production infrastructure with respect to a current portfolio, the method calculating a selected risk, such as a financial risk or Quality of Service risk and comprising:

a. invoking a performance evaluator means, to determine an expected actual Quality of Service provided by a network given a set of contracts with associated traffic descriptors;
b. calculating portfolio risk, based on the actual Quality of Service and the contracted Quality of Service of the contracts of the portfolio using a risk measure corresponding to the selected risk; and
c. computing return according to the formula $p_i y_i - p_C C$ for capacity C, expected revenue p_i, amount of contracts of

type i, y_i, and unit price for capacity C, p_C, where C is both an input in the performance evaluator and a characteristic of the production infrastructure.

13. The method of claim 12 wherein the performance evaluator means is selected from a group of performance evaluator means consisting of a formula, a simulator or test system, and a measurement system for the production system.

14. A computerized system encoded with a method having an associated process flow, the method managing the risk of financial loss due to penalties brought on by noncompliance with respect to network service-level agreements, characterized in that the method executes the following steps:

a. gathering information such as traffic statistics, price information, and network information;
b. inputting the gathered information into a risk and a return function, yielding risk and return;
c. calculating an efficient frontier; and
d. using the efficient frontiers to identify an optimum portfolio of service level agreements, based on a maximum level of return for a given risk or a minimum risk for a given level of return.

15. The system of claim 14, wherein, in the method, after an optimum portfolio is identified, trading service-level agreements in order to arrive at an optimum portfolio, the number of agreements of a certain class to be traded being determined by subtracting the number of SLAs of the certain class in the current portfolio from the number of SLAs in a desired portfolio, and taking action that tends to narrow the difference, thus moving the contents of the current portfolio to that of an optimal portfolio

16. The system of claim 14, wherein, in the method, the risk function is given by a probability of noncompliance with loss guarantees, *PNL*, which, once the distribution of $\boldsymbol{Y}$, a common random variable which represents the service times for customers of all classes is known such as through historical data, the method computes from the formula: $PNL(c, L) = P[(Y-c)+ - LY > 0]$, where c is $C/\underline{y}$, $\underline{y}$ is the summation of a total amount of accepted bandwidths of Quality of Service class L_i, C is overall capacity of the network, $\underline{L}$ is a vector which characterizes the quality of each SLA, and $P[\underline{x}]$ denotes the probability of $\underline{x}$.

17. The system of claim 14, wherein, in the method, the risk function is given by an expected penalty for loss, EPL, which the method computes over a time interval from the formula: $EPL\ (c, L) = (\beta C)\{E[(Y-c)+]- LE[Y]\}$, where c is $C/\underline{y}$, $\underline{y}$ is a summation of a total

amount of accepted bandwidths of Quality of Service class L_i, C is overall capacity of the network, $\underline{L}$ is a vector which characterizes the quality of each SLA, β is a constant >0, so that (βC) denotes the penalty per capacity unit, E is statistical expectation, and L_i is the total Quality of Service offered by class i.

18. The system of claim 14, wherein, in the method, the risk function is given by an expected penalty for delay, *EPD*, which the method computes over a time interval from the formula: $EPD\ (c, L) = \beta\{\ (\alpha\ /(c-1)) - (D/c)\}$, where β is a constant > 0, $c = 1/\Sigma(\lambda_i/\mu_i)$, $D = c\ \Sigma\ \{(\lambda_i/\mu_i)D_i\}$, and $E[W_i]$ denotes the expected waiting time (i.e., delay) for class i, wherein further, assumptions are made that class i traffic arrives at Poisson rate λ_i, and that arrival processes are independent of each other; service times, characterized by service rate μ of class i, are independently distributed and independent of each other and of the arrival processes; that $\alpha=(1+\{Var[Y]/\ \mu^2\ \})/2$ given that service times for customers of all classes are distributed as a random variable Y of mean μ, where $Var[Y]$ denotes the variance of random variable Y, and wherein noncompliance is a penalty for exceeding D_i and a premium for remaining under D_i.

19. The system of claim 14, wherein, in the method, the risk function is given by an expected penalty for delay, *EPD*, which the method computes, assuming Poisson traffic, from the formula: $EPD(v) =$

$\beta \sum_i v_i (E[W_i] - D_i)$, where $\boldsymbol{v}$ is a vector of traffic intensities, v_i is the traffic intensity of customers in class i, E is statistical expectation, β is a constant >0 so that βC denotes the penalty per capacity unit, W_i is waiting time for a class i, and D_i is the maximum permissible delay for a class i of SLAs.

20. A computerized system encoded with a method which manages operational risk and return with respect to network service-level agreements, wherein the method calculates a probability of actual loss higher than allowed by a contract and a return, and, applying the principals of portfolio theory, determines an efficient frontier to enable the selection of an efficient portfolio that maximizes return at a given risk or minimizes risk at a given return.

21. The system of claim 20 wherein, in the method, the return is calculated using an expected penalty for loss.

22. A computerized system, encoded with a method executing a process flow which manages operational risk and return with respect to network service-level agreements, operating over a computer network comprising a plurality of interconnected computers and a plurality of resources, each computer including a processor, memory and input/output devices, each resource operatively coupled to at least one of the computers and executing at least one of the activities

in the process flow, wherein the method manages a portfolio of service level agreements, each of which define a service level, a connection, a contract duration, traffic descriptors, quality of service guarantees and a probability of noncompliance with respect to the quality of service guarantees, the probability of noncompliance providing a contractual parameter wherein, after being accepted by a customer, noncompliance within the contracted limits does not trigger a penalty, thus avoiding penalties for noncompliance and thus reducing.

23. The system of claim 22, wherein, the quality of service guarantees include loss rate, delay, and jitter.

24. A computerized system encoded with a method which manages operational risk and return with respect to service-level agreements in a network, wherein the method manages a portfolio of service level agreements of at least two classes each of which representing relative compliance guarantees, wherein, a customer subscribing to a higher relative compliance guarantee has priority with respect to resources in the network, over customers having a lower relative compliance guarantee.

25. A computerized system encoded with a method which manages

operational risk and return with respect to network service-level agreements, wherein the method takes probabilities of noncompliance and base-line prices, and, through the application of portfolio theory, calculates an efficient portfolio of service-level agreements, thus providing a network administrator with insights into the economics of a network's operations which can be used to modify the terms of standard service-level agreements.

26. The system of claim 25, wherein the base-line prices are zero-profit prices.

27. The system of claim 25, wherein the base-line prices are market prices.

28. The system of claim 26, wherein the zero-profit prices are calculated by:

a. calculating a base-line efficient portfolio using market pricing and thus determining base-line prices;
b. investigating which of these portfolios are probably attainable;
c. comparing the base-line prices against a zero-profit price;
d. if the zero-profit price is higher than the base-line price, taking corrective action.